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A Contribution to the History of the Vertebrata of the Trias of North America. By E. D. Cope.

(*Read before the American Philosophical Society, April 15, 1887.*)

The vertebrata of the Trias of North America are not as yet well known, and scarcely twenty species have been described. Those known to the writer in 1870 are enumerated in the Transactions of this Society, Vol. xiv; and the species discovered in Pennsylvania are catalogued in the Proceedings of this Society for 1886, p. 403. Some species from New Mexico are described in the American Naturalist, 1881, p. 922,* and April, 1887. Descriptions of several forms from this formation, from the Rocky Mountain region, with plates, were given in the Report of the U. S. Geol. Geogr. Survey W. of the 100th Meridian, 1877.

I am now able to add descriptions of some new species from New Mexico; and furnish additional characters of species already described.

1. EUPELOR DURUS Cope. Transac. Amer. Philos. Soc., 1869, p. 25, V. xiv.

A good many fragments of this species or one nearly allied to it were obtained by Mr. C. M. Wheatley, in York county, Pennsylvania. These pieces are not all as yet identifiable, but one of them consists of a large part of the ramus of the lower jaw which supports the bases of the posterior teeth, but from which the cotyles and angles have been broken off. The bases of the teeth are cylindric, and show delicate grooves, being similar to those of Eryops, and proving that my original reference of teeth to this genus was probably correct. All the bones show the coarse honeycomb pattern of sculpture of the external surfaces characteristic of the species. Towards the margins of the bones the pits become confluent into radiating grooves. A subtriangular plate measures:

	M.
Length	.345
Greatest width	.140

* *Belodon buceros* and *B. scolopax* Cope.

The fragment of jaw measures:	M.
Depth at last tooth	.040
Length, including three teeth	.027

Nothing can yet be determined as to the characters of the vertebræ of this form.

2. Typothorax coccinarum Cope. U. S. G. G. Survey W. of 100th Meridian, Capt. G. M. Wheeler, 1877, iv, Pt. ii, p. 30. Pl. xxii, figs. 4, 5 and 9. American Naturalist, 1887, p. 468.

The genus Typothorax was distinguished by me, l. c., from Belodon, on account of the regularly pitted surface of the dermal bones. With such dermal bones others of a different character were found, which it was thought best to refer to the same genus, and a fragment of maxillary bone found near by was included in the description. I now suspect that the dermal bones which do not possess the pitted character belong to some other reptile, and the fragment of jaw is not to be referred, certainly, to the *Typothorax coccinarum*, but is more likely a part of a Belodont Saurian.

The additional material belonging to this genus and species which I possess consists of two ribs with corresponding dermal bones attached to their superior surfaces, and two femora, one of which adheres to one of the ribs. Also several other more or less incomplete dermal bones. There are numerous other bones accompanying, but their reference is not certain.

Char. Gen. The peculiarities of this genus as displayed by these specimens are as follows: Ribs greatly expanded but with free margins, each overlaid by a band-like dermal bone for its entire length. The dermal bones with pitted sculpture and straight, simple margins, the one acute and the other obtuse. The margins of the ribs are similar to each other. It results that a gaping groove is formed between the parallel acute edge of the dermal plate and the rib into which the appressed edges of the adjacent rib and plate enter and fit. Thus is formed a complete cuirass covering the body. Femur sigmoid, without distinct head or trochanters, excepting a prominent, ridge-like third trochanter on the posterior face. Condyles with a posterior lobe separated from the external lobe by a fossa.

It is possible that one of the ribs described is abdominal in position, as it does not appear to have had a head. There is no head preserved on the other. The dermal bands described may be therefore abdominal. The ribs are, however, strongly curved in the longitudinal direction, and it is to be supposed on this account that they are dorsal, and perhaps in the position of flying ribs. The adhesion of a femur to one of them indicates posterior position. The character of the femur is different from that of the Belodontidæ in its trilobate condyles, approaching thus the Goniopod Dinosauria. The third trochanter is much better developed than in any known Belodont.*

* Von Meyer Palæontographica, vii, 1861.

Future comparison must be had with the genus Aëtosaurus Fraas,* which accompanies Belodon in the Upper Keuper of Wurtemberg. That genus is encased in parallelogrammic scuta arranged in contiguous cross-bands, on both surfaces of the body. But the scuta are not co-extensive with the ribs as in Typothorax; at least the latter are represented by Fraas as much narrower than the osseous dermal bands. The latter are also transversely subdivided in Aëtosaurus.

It is highly probable, however, that Typothorax represent Aëtosaurus in the Upper Trias of North America, and may belong to the same family of the order Rhynchocephalia.

The relations of the dermal bones and ribs are highly interesting. The great expansion of the latter needs but the development of sutural surfaces on their borders to produce an osseous continuum. The same modification of the dermal bones above it would form a second external roof. A subsequent fusion of the superior and inferior roofs would give us the testudinate carapace. And this history would be what embryology teaches us is the origin of that remarkable modification of the dermal and true skeleton exhibited by that order of reptiles. It is probable that Typothorax is nearly allied to the type from which the order of tortoises has been derived. It is unfortunate that we know nothing of its skull and vertebræ, but there is nothing in the characters of the femora to preclude the above hypothesis. They belong to a type which progressed in a prone position, and which probably differed much from both Belodonts and other Dinosauria.

Char. Specif. Ribs strongly convex in the longitudinal direction; in the transverse direction flat above, and with a longitudinal convexity below. This convexity occupies about one-third of the inferior surface, and extends obliquely to one of the lateral borders at the extremity. At the other extremity the surface is flat, the rib-convexity disappearing. In both ribs one edge is subacute and the other obtuse. The rib-thickening runs out to the thin edge. The dermal scuta have the same width as the ribs. They have thicker and thinner edges corresponding with those of the ribs. Where the rib-thickening of the latter is prominent, the dermal bone has a median convexity below; and this disappears at the other end as the thickening does from the rib. The superior face of the dermal bones is perfectly flat. It is sculptured with coarse shallow pits, separated by obtuse ridges, which have a reticulate pattern, since the pits are not in rows.

These osseous bands are probably in contact, thus forming an impenetrable buckler, as in Aëtosaurus. One edge of the osseous combination of rib and dermal plate gapes, the thin edges of the two elements diverging so as to receive the margin of the adjacent band. The matrix along this border is clearly impressed so as to prove the former presence of the succeeding portion of the carapace.

* *Aëtosaurus ferratus* Fraas; Festschrift zur Feier d. vierhundertjährigen Jubiläums Univ. Tübingen, 1877.

Measurements.	M.
Length of rib on curve on inner side	.276
" " chord of rib	.250
Width of rib near proximal end	.090
" " " distal end	.074
Thickness of rib at proximal end	.005
" " " middle	.014
" " scuta at proximal end	.005
" " " " middle	.011
" " " " distal end	.008
Average diameter of fossæ of do.	.007

The *femur* is quite characteristic. The long axes of the extremities form an angle of about 45° to each other. The shaft is incurved from the third trochanter proximad, and is expanded more externally than internally at the distal extremity. The proximal extremity is rhomboid in outline ; the internal border convex, the anterior concave, the posterior less concave, and the postero-exterior nearly straight, and joining the anterior by an acumination with obtuse apex, which represents the great trochanter. Surface of head, flat-convex. The junction of the internal and external posterior faces is marked by a convexity ; and the shaft below the external posterior face is longitudinally concave. The third trochanter marks about two-fifths the length of the shaft, and is quite prominent. It is convex externally, and concave internally. Below it the section of the shaft is a transverse oval, wider exteriorly. The condyles of the femur are considerably expanded transversely, the external being the most produced. The rotular groove is shallow but distinct. The external condyle, as already remarked, has a distinct posterior lobe, which is separated from it externally by a large ? ligamentous fossa within the bonndary of the articular surface. This posterior lobe is well within the exterior border, and bounds the intercondylar groove on the external side. It presents posteriorly, and is narrowed and obtuse. A corresponding part of the internal condyle presents posteriorly also.

Measurements of femur.			M.
Total length (axial)			.230
Diameters of head	anteroposterior (greatest)		.060
	transverse (axial)		.035
Anteroposterior diameter at great trochanter			.031
Diameters of shaft	anteroposterior		.022
	transverse		.030
Diameters of condyles	transverse		.081
	anteroposterior	internally	.040
		at groove	.032
		at posterior lobe	.051

The parts of this individual preserved indicate an animal of the average size of the Mississippi alligator. More perfect specimens will be awaited with much interest.

3. Episcoposaurus horridus. Gen. et sp. nov.

This species is indicated by a number of bones which were excavated at the same place. They are : Two caudal vertebræ, a proximal and a distal ; a humerus ; two ulnæ ; a femur lacking the condyles ; a proximal part of a tibia ; the distal part of a fibula ; a calcaneum, and a number of dermal bones. The only part of the skull possibly belonging to this animal is a splenial bone.

Char. Gen. The generic characters, so far as ascertainable from the materials, resemble those of Belodon with certain exceptions. Chief among the latter is the disproportion, in dimensions, between the anterior and posterior extremities, which is as great as that existing in many Dinosauria proper. Appropriately to this relation, the femur differs from that of Belodon in the absence of curvature of the shaft, having the straight form of that of most Dinosauria proper. There are no trochanters of any kind on this femur, and its head has the wedge-shaped Belodon outline. The head and condyles of the humerus are transversely expanded ; the shaft is contracted ; condyles not specialized. No epicondylar foramina of either side, but a strong ectepicondylar groove, which cuts off a narrow ectepicondylar ridge, which terminates freely. The caudal vertebræ are elongate, indicating a powerful tail. But one species is yet known.

Char. Specif. The body of the anterior caudal vertebra has a wedge-shaped section, the apex inferior, representing the section of an obtuse median keel. The articular faces are subcircular, widening upwards. Both are concave, the posterior more so than the anterior, which is nearly plane. No lateral ridges on the body. Arch lost. The posterior caudal is long and slender, and has a long compressed neural arch. The section of the body is heptagonal, as there are two low lateral angles on each side, and an obtuse median inferior keel. The inferior lateral angle is stronger than the superior. There is not so much difference in the concavity of the articular extremities, as in the case of the larger vertebra.

Dimensions of caudal vertebræ.		M.
Length of centrum of anterior vertebra		.070
Diameters of anterior face	transverse	.050
	vertical	.048
Length of centrum posterior vertebra		.069
Diameters anterior face	transverse	.033
	vertical	.031

The *humerus* is remarkable for the small diameter of its shaft as compared with the expanse of its extremities. The long axes of these extremities make an angle of about 45° with each other. The articular surface, which is co-extensive with the head, is long and narrow, widening gradually to the inner rounded extremity. Viewed in profile it is strongly convex, the convexity being a little nearer the internal than the external extremity. The articular surface descends on the inner edge of the bone towards but not to the bicipital crest. Viewed proximally, the convexity of the head is as wide as the inner extremity, and is distinguished from it by a concavity of the inner side. The bicipital crest is the incurved external border. It commences opposite the prominence of the inner extremity of the head, and extends but a short distance down the shaft. It is quite prominent. The face of the bone below the head displays a very shallow concavity. The posterior face is recurved towards the two margins, as we approach them. The shaft is very much contracted. Its section at the middle is a wide oval; the external edge subacute, the internal broadly rounded. The distal extremity is much expanded, though not so widely as the proximal end. The expansion is greater internally than externally. Neither epicondylar prominence, however, extends much beyond the articular surface. The latter is rather narrow, and is curved, the concavity anterior. The two extremities are wider than the middle region, the external part being the widest. There is a deep groove on the posterior face near the external edge, which runs out, leaving the external epicondylar process to terminate at about 20 mm. proximad of the condyle. The latter terminates outwards in an acute angle, which marks the internal edge of the ectepicondylar groove. The epitroclear fossa is well defined. Posterior face plane.

Measurements of humerus.

				M.
Total length				.220
Diameters of head	long (straight line)			.088
	transverse	internal		.025
		greatest (submedian)		.024
		least (external)		.015
Diameters at middle of shaft	anteroposterior			.021
	transverse			.027
Diameters of distal end	transverse	with ectepicondylar crest		.076
		below " "		.072
	anteroposterior	internal		.021
		median		.018
		external		.029

The *ulna* is characterized by its small size, and its great compression, especially of the distal half. The olecranon is deep, but it scarcely projects behind the cotylus, where it is more prominent than at the inferior border. On the external side a regular convex mark extends from the base of the coronoid process to the inferior posterior angle. Behind this arc-like border, the surface of the bone is dense and smooth, as though for a cartilaginous cap. What this structure indicates it is difficult to understand, as it is clearly not a muscular insertion. The coronoid process is quite prominent. The external face of the shaft is convex in the vertical section ; the internal flat. The vertical diameter increases a little at the distal extremity. The latter is in the plane of the shaft, and is gently convex in both directions. Its narrow proportions indicate a correspondingly feeble carpus.

Measurements of ulna.		M.
Total length		.161
Depth of ulna	at olecranon	.037
	at coronoid process	.055
	at middle of shaft	.026
	at distal extremity	.035
Width of ulna	at cotylus	.022
	at middle of shaft	.010
	at distal extremity	.012

Parts of the *radius* resemble considerably that of a mammal. The head as a transverse oval, slightly concave, and the shaft is quite narrow, and with an oval section.

Measurements of radius.		M.
Diameters of head	transverse	.035
	vertical	.020
Diameters of shaft	transverse	.015
	vertical	.012

The *femur* is the characteristic bone of the genus. The specimen preserved lacks only the condyles. The remainder of the bone is perfectly straight. The inner face of the shaft is rounded, becoming flat as it approaches the head. The external edge is an angle which vanishes above the middle of the shaft, to reappear again as a narrow ridge which terminates in the external extremity of the head, which is homologous with the great trochanter. A well-developed obtuse ridge, above the middle of the shaft on the posterior face, represents the third trochanter. The head occupies the entire proximal extremity. Viewed proximally, it is pyriform, with a concavity of the anterior, and a convexity of the posterior outline. The external extremity is narrowed ; the internal is broadly rounded. A wide groove occupies the center of the entire articular surface. Below the middle the shaft is uniformly convex in front ; while posteriorly there is a shallow groove just within the external edge.

Measurements of femur.		M.
Length of fragment preserved		.315
Diameters of head	internal	.057
	median	.052
	exterior	.030
Diameters of shaft below 3d trochanter	anteroposterior	.041
	transverse	.052

The *tibia* is represented by the proximal end only. It is much like that of Belodon, but, like the humerus, is characterized by a relatively small diameter of the shaft. The outline of the head is wide-reniform, the shallow concavity posterior. The articular surface descends on each side of this concavity, giving a convex outline to the superficial layer of the posterior face of the bone. Anteriorly the articular region projects further to one side than to the other, perhaps leaning to the external side.

Measurements of the tibia.

		M.
Diameters of head of tibia	anteroposterior (middle)	.073
	transverse	.107
Diameters of shaft	anteroposterior	.032
	transverse	.043

The distal end of the *fibula* is robust. One face of the shaft is concave; the opposite one is convex. On the concave side, one-half the bone projects distad abruptly beyond the other half. On the convex side, the edge of the articular extremity winds obliquely from the one level to the other. This indicates the fact that the articular face forms a segment, equaling three-fifths, of a spiral.

		M.
Diameters distal end of fibula	transverse (axial)	.080
	anteroposterior	.048

The *calcaneum* has the form usual in crocodiles, and especially in Belodontidæ. It is wider and flatter than in any species known to me. The external rim extends from the anterior to the posterior extremities, and is quite expanded. The distal extremity is pyriform, and its recurved edges bound posteriorly a deep fossa on both the superior and the inferior aspects of the bone. These fossæ are continuous by the open concavity of the internal margin. This margin is flared inwards in front by its truncate anterior face, which bounds the astragaline fossa behind. The latter is wider than deep. The articular surface is divided into two planes; a narrow interior for the tibia, and a wider exterior for the fibula. Both are convex anteroposteriorly, and nearly plane transversely.

Measurements of calcaneum.

		M.
Anteroposterior diameters	longest	.90
	at astragaline fossa	.52
Transverse diameters	anteriorly	.50
	median (greatest)	.91
	posterior	.74

The *dermal bones* are of three types, of each of which I select an example. They are all, or nearly all, furnished with a prominence of the superior surface, which is more or less compressed, and which is abrupt at one face, and produced into a keel at the other extremity in the direction of the axis of the bone. All the bones preserved are unilateral in type. The simplest form is oval-parallelogrammic, with a low obtuse median keel, which rises at one extremity into a moderately compressed knob, which terminates abruptly. Shallow grooves separated by ridges radiate from this prominence in all directions. On its sides the sculpture becomes smaller and more irregular. In the second type of bone, the median keel is elevated into a crest which extends the entire length, and cannot be distinguished at any point as a knob. The section of such a bone is triradiate, and it is not always practicable to state which of the three laminæ is the free one. In any case the latter is not median on the fixed portion.

In the third type of dermal bone, the free keel is much developed and rises into a tuberosity so produced as to be a well-developed spine. The inferior surface of the bone is longitudinally concave. The section of the spine is triangular, the apex being the sharp edge which is the continuation of the keel. The sharpness of this edge is such as to render it probable that these spines constituted dangerous weapons of defense. One side of the spine is nearly vertically over the edge of the base, while the other is within the other edge. The surface of the bone is perfectly smooth. None of the dermal scuta of Belodon described by Von Meyer are developed into spines like those of this species.

Measurements of dermal bones.

		M.
No. 1.		
Diameters	anteroposterior	.100
	transverse	.070
Elevation of knob		.031
Distances of knob	from one end	.080
	from the other end	.020
No. 2.		
Length		.085
Elevation of laminæ	No. 1	.037
	No. 2	.016
No. 3.		
Diameters of base	anteroposterior	.096
	transverse	.034
Elevation of spine	from lateral border	.085
	from inferior groove (oblique)	.053
Diameters of spine at base	anteroposterior	.040
	transverse	.020

4. Belodon buceros Cope. American Naturalist, 1881, p. 922.

Some years ago* I identified certain fossils discovered in North Carolina by Emmons as Belodons; and later,† referred a species found by Wheatley in Pennsylvania to the same genus. I was subsequently able to prove that the genus ranged over the Rocky mountains, and that there, as in other parts of the world, it haunted the shores of the Triassic seas and lakes. There are two species of Belodon in my New Mexican collections,

* Proceedings of Academy of Natural Sciences, Philadelphia, 1866.
† Transactions Amer. Philos. Soc., xiv, 1869.

one as large as the gavial of India, the other smaller. In the former the muzzle is keeled above, and rises into a crest in front of the nares. In the other species the muzzle is subcylindric, and does not rise anterior to the septum of the nostrils. The larger species I call *Belodon buceros;* the smaller one *B. scolopax*, and define them below. Bones of the skeleton and of the dermal systems of this genus are common in the New Mexican beds, but I am yet unable to refer them positively to the species represented by the skulls.

Char. Specif. Size of the gavial. Muzzle slender, compressed, with a narrow median superior ridge, rising at the middle of the length into a compressed crest, whose summit is in the plane of the frontal region. Nostrils a little further anterior to the orbits than the diameter of the latter, longer than wide, and separated by a thin septum. Orbits round, looking a little upwards, the interorbital region a little narrower than each orbit. Preorbital region compressed; preorbital foramen large, inferior. The quadrate bones are directed forwards, and then downwards, and their articular faces are in the transverse line of the two rather narrow notches of the posterior outline of the pariëtal bone. The auricular meatus is bounded posteriorly by a descending hook-like process; and the squamosal bone is continued still further posteriorly into a short triangular acute horn. The superior surface of this bone, with the pariëtal and frontal, are roughened with tubercles. The palate has a strong ridge on each side, so as to be grooved. The posterior teeth have compressed denticulate crowns. Tip of muzzle lost. Total length preserved, M. .700; length of muzzle to posterior edge of nares, .420; do. from latter to lines of anterior edge of orbits, .060; do. from do. to posterior pariëtal notch, .160. Width at posterior border of quadrate condyles, .260; interorbital do., .048; do. at slender part of muzzle, .045. Depth of slender part of muzzle, .050; do. of elevated part, .120; do. at pariëtal region, .140.

This species is of the size of the *B. kapfi* Meyer, and is, in the form of the muzzle, intermediate between that species and the *B. plieningeri.*

Foramina. The alisphenoid bones embrace the olfactory lobes of the brain as far forwards as the middle of the orbits, when they contract to a foramen of moderate size. The under face of the median line of the frontal bones is openly grooved in continuation. The basioccipital has a horizontal axis, and is about as long as wide, including the condyle. Its anterior border has a median apex or projection on the sphenoid. The latter forms a transverse band of small anteroposterior diameter to a sharp transverse truncation or anterior border. Whether this is the boundary of this element or not is uncertain. It is probably merely a transverse crest, since in front of it the basicranial axis is continued. The latter is deeply concave in the middle, but sends downwards a process on each side, which fits into a notch of the posterior internal border of the pterygoids. Between these notches the pterygoids underroof the axis, and unite on the median line. This union has a less anteroposterior extent than is represented by

Von Meyer in the *B. kapfi*,* and the posterior nostrils, which commence in front of this union, have a much greater anteroposterior extent than in that species.

There is a fossa in the posterior part of the orbit which extends downwards and forwards. In the superior part of its fundus is the mouth of a canal which extends from the pineal fossa of the brain case. I call this the *orbito-pineal* canal. It will be again referred to in the description of the brain. Below the anterior part of this fossa, and at the base of the closed interorbital part of the brain-case, is the large optic foramen. It looks outwards and forwards, and it is not certain that it is separated from that of the other side by a septum. The lateral walls of the brain-case are imperforate. There is no foramen for the trigeminus in the usual position. A portion of the superior face of the sphenoid bone is split away, and it may be supposed that the trigeminal foramen was at the base of the brain on the line where the lost portion joined the lateral walls. It must have been of small size. A canal traverses the basioccipital bone on each side, commencing in conjunction with that of the opposite side, and extending outwards and backwards, and issuing on the suture joining the basi- and exoccipital bones.

Brain. The cast of the brain-case presents several peculiarities of importance. The size is a little greater than that of an *Alligator mississippiensis* whose skull slightly exceeds that of the *Belodon buceros*. Thus the dimensions of the former are, length 500 mm., width at quadrates 290 mm.; of the *B. buceros*, length 700 mm., width 240 mm. The distribution of parts is different. The prosencephalon is relatively and absolutely smaller in the Belodon, and the mesencephalon is larger. The epencephalon is not very different in the two, and the contraction on each side of it is apparent in the one as in the other. Posterior to it, the medulla is contracted to a still smaller diameter in a manner not seen in the alligator. This region is longer in the Belodon than in the latter. The brain proper is thus bunched up or shorter and more elevated in the Belodon than in the alligator. The contraction to the rhinencephalon is more abrupt in the Belodon. What gives the Belodon its especial character is the presence of an enormous epiphysis. This body is subquadrate in form, and occupies a large fossa in the cranial roof, which is, however, not perforate. On each side of the anterior portion a process extends outwards and forwards, occupying a corresponding anteroposterior fossa in the cranial walls. The process is continued, horn-like, on each side, and the cast forms a continuum through the orbitopineal canal to the orbit. Whether this represents a nervous or arterial canal can only be surmised, but from the size of the process of the epiphysis which enters it, I suspect that a nerve formed part of its contents. There is no median distinction between the halves of the prosencephalon and mesencephalon in the brain-case, thus resembling other crocodiles. The mesencephalic bodies were probably lateral, judging from the greater width of the cast below at the middle, as com-

* Palæontographica, Vol. viii.

pared with the contraction of the part behind the epiphysis. The hypophysis is distinct but not large, and occupies a fossa of the base of the cranial cavity, very much shorter than that possessed by the *Alligator mississippiensis.* The optic nerves issue immediately above and anterior to it.

Comparison with the brain of Diadectes. In these Proceedings for 1885, p. 234, I have described a cast of the brain-chamber of a species of the Diadectidæ from the Permian bed of Texas. As a successor of the Diadectes, and as descendent of probably one of the Clepsydropidæ, considerable interest attaches to a comparison of the brain of Belodon with it.

The first point which arrests the attention in making the comparison, is the similarly huge size of the epiphysis in the two types. A foramen on each side of the base of the epiphysis in the Diadectes gave exit to a process similar to that which enters the orbitopineal canal in the Belodon, and which I called the lateral process of the epiphysis in the latter. (Plate, figs. 1–3, l f). The processes are probably homologous in the two genera, but in the Diadectes they did not extend to the orbit, unless they were continued in membranous walls. There is little resemblance between the two brains in other respects, but they agree in the small size of the prosencephalon, and in the complete enclosure of the rhinencephalon by osseous walls. In the Diadectes there is no optic foramen, but a huge trigeminus; in Belodon, an optic foramen, and a very small trigeminus.

The presence of such a huge epiphysis in the Belodon as compared with its very small size in modern crocodiles, is a point of much interest, and points to its inheritance from the reptiles of the Permian. But if, as is probable, it contained the pineal eye, the latter could not receive light directly from above, since the pariëtal foramen is wanting. The presence of a communication with the orbit becomes interesting in this connection. A minute foramen passes from the base of the rhinencephalon into the orbit in the alligator, but the homology with the *canalis orbitopinealis* is by no means made out. The *nervus orbitopinealis* may have supplied the lack of light due to the closure of the pariëtal foramen, but in what way we are left to conjecture.

The equality of size of the brain of the Belodon to that of the existing alligator is a point of interest.

There is some reason to suspect that the Diadectes relied exclusively on the pineal eye for the sense of sight. The species of the family were probably subterranean in their habits, since their humeri indicate great fossorial power, resembling those of the existing monotremes, and even the mole. The vertebræ are locked together with the hyposphen beside the usual articulations, and the arches of the neural canal form an uninterrupted roof from the skull to the tail, of extraordinary thickness and strength. That the species were not aquatic is rendered probable by the fact that the orbits do not look upwards. Their superior borders are, on the contrary, prominent and straight. Add to this fact the apparent absence of optic foramina, and the probability that the Diadectidæ were blind and subterranean in their habits becomes great.

5. Belodon scolopax Cope. American Naturalist, 1881, p. 923.

This species is represented by a snout, which includes the anterior border of the nares ; it is broken into five pieces, which should be connected with intermediate fragments, which are lost. This muzzle is a little shorter than that of *B. plieningeri*, but is a good deal more slender, the distal part having only half the diameter of the latter. Besides this character, it differs from that of *B. plieningeri* in three others. The extremity of the muzzle is not so much decurved. All the alveolæ have a more lateral exposure, and the lateral ridges of the palate are thus more distinctly seen from the side. The two teeth on the extremity of the muzzle are closely crowded together, and their large alveolæ are scarcely distinct.

The surface of the muzzle is distantly and weakly grooved and punctate. The anterior alveolæ are round, the posterior ones oval. Diameters an inch anterior to nares : transverse, .0230 ; vertical, .0235. Diameters three inches from extremity : transverse, .019 ; vertical, .0145.

6. Tanystrophæus longicollis Cope. *Cœlurus longicollis* Cope. American Naturalist, April, 1887 (pub. May 4th), p. 368.

Numerous fragments of this genus are in my collection from the Triassic beds of New Mexico. The vertebræ resemble in various essential characters those which are preserved and described by Marsh as belonging to the species of his genus Cœlurus, and I therefore referred the present species to that genus, as above cited. It is now clear to me that the Triassic species must be distinguished from Cœlurus. Prof. Marsh states that the anterior cervical vertebræ of the latter have the anterior articular surfaces convex, while the posterior are concave. In the Triassic species the third cervical is concave at both extremities, thus resembling the posterior centra. In searching for a name for the Triassic genus, I find that the Tanystrophæus of Von Meyer will probably include the American species in question. This genus was established on caudal vertebræ which nearly resemble those of the New Mexican species. For the present then I will retain for them the generic name first given to the *Tanystrophæus conspicuus* of the Trias of Würtemberg.

The bones in my possession are from all parts of the skeleton, excepting jaws and teeth ; fragments of skull, if present, are not yet determinable. These show that Tanystrophæus with Cœlurus,* must be referred to a family of the carnivorous suborder (Goniopoda) of the order Dinosauria. The acetabulum is widely perforate, its pubic and ischiadic processes being widely separated from each other. The pubis has a slender shaft directed downwards, as in Compsognathus, and in Creosaurus† as figured by Marsh, with an anteroposterior expansion proximally, but no symphysis distally. On the other hand the ischia have a symphysis. The

* Amer. Journal Sci. Arts, p. 339, Plate x.

† Amer. Journal Sci. Arts, 1884, Pl. xi, l. c., p. 340.

claws are compressed and strongly curved, and capable of very extensive flexion and extension. I cannot therefore agree with Prof. Marsh that Cœlurus cannot be referred to any known order.‡ It is in fact allied to Megadactylus (Hitchcock) from the Trias of Massachusetts, differing principally, so far as determinable, in the form of the condyles of the femur. They are simple in Cœlurus, but in Megadactylus, the external condyle has the double character seen in Megalosaurus.*

The vertebræ are all of slender proportions, especially those of the neck and tail. These, with most of the bones of the limbs, are hollow, having large central cavities surrounded by thin walls, as in Megadactylus. The parapophyses are confined to the anterior parts of the centrum. In the cervical and dorsal vertebræ there is a conical fossa at each base of the neurapophysis, which unite by their apices in the cervicals, forming a canal distinct from that for the vertebral artery. The zygapophyses are partly interlocking, having convexo-concave oblique articular surfaces. There are four vertebræ of the sacrum (in *T. bauri*), whose arches are coössified as well as the centra. The anterior caudal vertebræ only have chevron bones. Prof. Marsh says they are wanting in the genus Cœlurus; but he does not appear to have possessed the most anterior of the series. In neither species is there a distinct third trochanter of the femur; but there is not far below the great trochanter on the anterior face, a low longitudinal, ridge-like angle. The femoral condyles have but little antero-posterior extent, which implies but little flexure of the knee.

The form seems to have been that of a terrestrial reptile which walked readily on the hind legs, and was probably a great leaper. The extremely long neck is a striking peculiarity, having proportions to the body about like that of the swan. The habits were probably predaceous and carnivorous.

Three species are indicated by my collections.

Char. Specif. Cervical vertebræ one-third longer than those of *Cœlurus fragilis* Marsh, the sides of the centrum not sulcate, the anterior articular face of an anterior centrum not convex. The faces are oblique, showing that the head was carried above the level of the body.

		M.
Length of body of ? third cervical vertebra		.063
Diameters of posterior cup	vertical	.016
	transverse	.019

The *dorsal centrum* has subround articular faces, which are gently concave, and a much contracted shaft. The section of the latter is subround, a little flattened below. The inferior border of the neural arch is coössified and extends well down on the side, its inferior border being marked by an open longitudinal groove. On the superior border of the middle of this groove is an indistinct tuberosity. Above this line at the middle of the neural arch a thin longitudinal broken ridge probably repre-

* See Cope, Trans. Amer. Philosoph. Soc., xiv, 1870. Pl. xiii.

sents the base ot the diapophysis. It is bifurcate for more than one-third of its length at each end, the bounding walls embracing a deep conical fossa. The walls of the centrum are thin, including a large central cavity.

		M.
Length of centrum of dorsal vertebra		.042
Diameters of posterior face	vertical	.020
	transverse	.021
Elevation of centrum to middle of diapophysis		.022
Transverse diameter of neural canal		.006

A caudal centrum is much elongate and has somewhat oblique articular surfaces, though they are not so strongly so as in the case of the cervical vertebra. The arch is lost from the specimen, so that nothing can be said of the diapophyses. The articular surfaces are distinctly concave, and the anterior is a little wider than deep, while the posterior is as wide as deep. The middle of the centrum is depressed, giving a well-defined inferior lateral longitudinal angle. There is also a low median inferior angle, which gives way posterior to the two ridges that terminate in the chevron facets, which are separated by a groove.

		M.
Length of caudal centrum		.051
Diameters posterior face	vertical	.023
	transverse	.021

Another caudal vertebra is much smaller, and has no chevron facets. It is more depressed than the larger one above described, and it has a wing-like lateral angle which connects the superior parts of the articular surfaces. Inferior surface flat, bounded on each side by a low angle. Neural arch distinct. It is a question whether this vertebra belongs to this species. It appears to me to be one of the terminal caudals.

		M.
Length of centrum		.035
Diameters of posterior extremity	transverse	.0105
	vertical	.0075

The *ilium* consists almost exclusively of a frame for the large acetabulum, and supports for the pubis and ischium. The anterior and posterior extensions are insignificant. The anterior process is somewhat depressed ; the posterior is compressed. The external border of the acetabulum is produced, forming a roof, which is continued nearly to the articulation of the pubic process, and which ceases at a greater distance above the articulation with the ischium. The inner acetabular border is produced downwards, partially closing the acetabulum at its fundus. The pubic articular surface is rather larger than the ischiadic, and has a gently sigmoid longitudinal section, the middle being concave. The pubic surface is on the contrary gently convex in all directions, its outline being triangular. The apex of the triangle is continued into the posterior border of the acetabulum. The sacral or internal side of the ilium is flat.

Measurements of ilium.

	M. No. 1.	No. 2.
Anteroposterior extent at articulations below...	.065	.086
Depth at pubis	.036	
" " ischium	.042	
Anteroposterior diameter acetabulum	.035	.049
Width above acetabulum	.021	.034

The ilium No. 2 may belong to a species distinct from No. 1, as it possesses an anteroposterior crest continued upward from the interior or sacral face, and the external roof of the acetabulum is sloped downwards exteriorly. The question of distortion prevents me from deciding the meaning of these differences at present.

The *pubis* is a very elongate bone, with a proximal extremity widely dilated anteroposteriorly. The proximal end is fan-shaped, the expansion from the axis being posterior. The proximal extremity is narrow, but is widest anteriorly, and displays three surfaces. The anterior one is for the ilium, the middle one is part of the acetabular border, and the posterior and narrowest is for the ischium. The foramen for the internal femoral artery is below the acetabular portion. The anterior border of the pubis to the extremity is rib-like, while the posterior is laminiform. The internal lamina is continued from the antero-internal face, and forms a concavity with the postero-external. Its exact width is not determinable for a good part of the length, for owing to its tenuity its edge is broken off. The distal extremity does not appear to have been united to that of the other side; if it was it could only have been by the laminar edge. The extremity is something like the head of a crocodile's humerus, the laminar edge terminating in the usual position of a deltoid crest. The shaft of the pubis is nearly straight.

Measurements of pubis.

		M.
Length of shaft (a small part wanting)		.228
Diameters proximally	anteroposterior	.057
	transverse (widest)	.020
Diameters distally	anteroposterior	.023
	transverse	.012

The *ischium* is less perfectly preserved, the head and the distal parts only remaining. The ischia form a long symphysis distally, but are not suturally united or coössified. The distal end is moderately expanded anteroposteriorly, and resembles in section a half ellipse. The proximal end has the iliac face a little concave, and the acetabular surface oblique to it, and more concave. The pubic contact is broken off.

Measurements of ischium.

		M.
Diameters proximally	anteroposterior	?
	transverse	.024
Diameters distally	anteroposterior	.030
	transverse	.014

The confluent extremities of the ischium form a surface of contact with the earth on which the animal probably rested at times, as I have suspected to be the case with the genus Megadactylus.* The pubes are directed downwards, and being longer than the femora have projected below the knees. It is probable that the animal rested on the apices of these bones also, as suspected by Marsh in the case of the Goniopoda of the Jurassic.

The *femur* is remarkable for the incurvature of the proximal extremity, so that it might be said to have a neck, but that there is no great trochanter. This form is necessary to avoid contact with the large pubic region. The shaft is a slightly flattened cylinder at the middle, and is a little flatter below. Rotular groove slight. Internal condyle narrower than external, and produced a little farther posteriorly.

		M.
Length of femur		.215
Diameters of condyles	anteroposterior	.024
	transverse	.030
Diameters of shaft at middle	anteroposterior	.014
	transverse	.016

Neither bones of the lower leg nor of the tarsus are certainly preserved. A phalange is of considerable size, and indicates perhaps the first of the internal digit, which is especially large in Megadactylus. The trochlear surfaces are well marked and smooth, the proximal simple, the distal hour-glass-shaped, and with well-marked lateral ligamentous fossæ. The two ligamentous insertions of the proximal extremity are well developed and of unequal size.

		M.
Total length		.043
Diameters, proximal	vertical	.018
	transverse	.015
Diameters, distal	proximal	.013
	transverse	.013

An *ungual phalange* is remarkable for its abrupt but regular curvature, and its great compression. The superior edge is the arc of a circle whose center is on the inferior edge just in front of the ligamentous insertions. The latter form a ridge of each side, just in front of the articular face, and are separated by a deep fossa. The insertion of the extensor ligament is a concave triangular space above the articular surface. The apex is lost.

Vertical depth of unguis	.018
Width do. at base of articular face	.010

This unguis is so proportioned as to have fit the penultimate phalange

* Transac. Amer. Philos. Soc., 1869, Plate xiii.

of the digit to which belonged the phalange previously described above. It indicates powerful prehensile use of the feet.

The *Tanystrophæus longicollis* was about the size of a greyhound. Its neck was like that of a swan, and its tail was of considerable length.

7. TANYSTROPHÆUS BAURI Cope. *Cœlurus bauri* Cope. American Naturalist, 1887, p. 368.

Almost as much of this species is preserved as of the last. There are no phalanges, but everything else is represented, including several cervical vertebræ, none of which are complete. There is a probable head of a tibia.

The differences are seen in the peculiarities of the cervical vertebræ and of the femur, and in the inferior size. The sides of the cervical centra are deeply and widely grooved on the posterior half, and the superior face of the neural arch is strongly grooved on each side on the anterior half. The femur is not so strongly grooved at the third trochanteric ridge on its exterior side, as in the *T. longicollis*.

		M.
Diameters of anterior face of third cervical	vertical	.010
	transverse	.0115
Width of do., including parapophyses		.017
Diameters of cervical centrum, behind	vertical	.0115
	transverse	.013
Length of dorsal vertebra		.030
Diameters do. posteriorly	transverse	.015
	vertical	.014
Length of sacrum		.073
Diameters of anterior sacral centrum, in front	vertical	.014
	transverse	.015
Diameters of head of pubis	anteroposterior	.032
	transverse	.010
Diameters head of ischium	anteroposterior	? .023
	transverse	.013
Diameters distal end ischium	anteroposterior	.020
	transverse	.013
Transverse diameter of femoral condyles		.022
Diameters head of tibia	anteroposterior	.024
	transverse	.018

The head of the *tibia* is trilobate posteriorly. The outline is anteroposteriorly sigmoid, the spine turning outwards and forming an acute angle. From this apex both borders are strongly sigmoid, the external commencing with concavity, the internal with convexity. The distal end of the ischium is oblique to the long axis of the bone, and its outline is triangular; the external convexity being stronger than in the *T. longicollis*.

The *sacrum* consists of four rather elongate centra, which have a subquadrate vertical section. A portion of an ilium adheres to it in the specimen, which is almost as large as that of the *T. longicollis.* If the ilium belongs to the same individual as the sacrum, the latter must belong to the *T. longicollis;* but I suspect that the association is accidental.

The diapophyses for the ilia are on the second, third and fourth sacral vertebræ. The second is directed forwards and upwards, the others backwards and upwards. There is a large deep fossa (or ? foramen) above the posterior halves of the second and third centra. The coössified bases of the diapophyses form a thin overhanging ledge.

8. Tanystrophæus willistoni sp. nov.

This, the smallest of the species, is represented by an ilium, from which the ischiadic process has been broken away, and probably by some vertebræ and other bones. The latter can only be associated with the ilium on account of their appropriate size, since they were found with those of the two other species mingled together in one locality.

The ilium is at once to be distinguished from those of the species already named, by the equal elevation of the internal and external superior borders of the acetabulum. The latter is as widely open internally as externally, which is not the case with the other species. The external superior border, though more produced than the internal, is not so roof-like as in the others. The anterior process above the pubic process is compressed. The pubic surface is sigmoid in vertical section, even more strongly than in the other species. The superior plate of the ilium is much compressed.

Width of roof of acetabulum	.015
" " pubic surface	.0095
Length of " "	.008

The dorsal centrum may be that of a young animal, since the neural canal is larger than in the larger species, and the neural arch is not coössified. The median portion is not so contracted as in the other species, and its section is rounded quadrate. Articular faces a little wider than deep.

Length of centrum		.019
Diameters of centrum	vertical	.008
	transverse	.010

Dedicated to Professor S. W. Williston, of Yale College, the author of numerous important works on vertebrate palæontology.

Remarks.—From the above determinations a close parallelism between the Upper Keuper of Würtemberg and New Mexico may be discovered. In both the genera Belodon and Tanystrophæus are abundant, and the Aëtosaurus of the former is represented by the Typothorax of the latter. This association of such very diverse forms is good evidence of general identity of fauna, and is a sufficient basis for asserting taxonomic identity of the formations in the two regions.

EXPLANATION OF PLATES.

Plate I.

Bones of *Typothorax coccinarum* Cope, two-fifths natural size.

Fig. 1. A rib, from below.

Fig. 1*a*. The same with dermal bone, edge view.

Fig. 1*b*. The same, view of fractured extremity.

Fig. 2. Another dermoösseous band, one end wanting, from above.

Fig. 3. Femur, right side, from behind.

Fig. 3*a*. Do., proximal view.

Fig. 3*b*. Do., distal view.

Plate II.

Casts of brain-cases of *Belodon buceros* and *Alligator mississippiensis*, natural size.

Figs. 1–3. *Belodon buceros.*

Figs. 4–5. *Alligator mississippiensis.*

Fig. 1. Left side.

Fig. 2. Superior surface.

Fig. 3. Front view.

Fig. 4. Left side.

Fig. 5. Front view.

RE. Rhinencephalon.

PE. Prosencephalon.

ME. Mesencephalon.

Ep.E. Epencephalon (Cerebellum).

MO. Medulla oblongata.

Ep. Epiphysis.

Hyp. Hypophysis.

ii. Optic nerve ; v. Trigeminus ; vi. Abducens ; viii. Facialis ; viii. Auditorius.

OP. Orbitopineal process or nerve.